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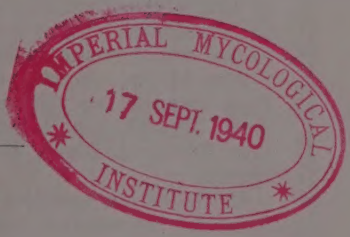
YELLOWS-RESISTANT VARIETIES OF CABBAGE SUITABLE FOR NEW YORK STATE

O. A. REINKING AND W. O. GLOYER



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ABSTRACT

CABBAGE yellows is caused by a parasitic fungus known as *Fusarium conglutinans* that invades the roots of the plant and grows into the water-conducting tissue of the stem. Once the fungus becomes established in a field it will persist for many years regardless of the crop grown.

Because the cabbage industry in certain localities already is threatened by the yellows disease, growers should become acquainted with the nature of the disease and the possible control measures that have been devised.

Three years' results of replicated and commercial field tests with cabbage yellows disease-resistant varieties of the early, mid-season, and late types are presented. These were tested on infested as well as on disease-free soil alongside the ordinary susceptible varieties now being grown. Data on their productivity, disease resistance, and general characteristics are presented.

Every effort should be made to prevent the spread of the fungus to non-infested fields. Ordinarily it is introduced on transplants grown in infested seedbeds or on tools, cabbage refuse, or particles of soil from infested fields. The grower should use only seedlings grown in non-infested seedbeds. In addition, care should be used in communicating between infested and non-infested fields. Tools used in infested fields should be thoroly cleaned and preferably washed with 5 per cent formaldehyde solution.

Once the fungus is introduced into a field resistant varieties should be planted. The better strains of the resistant varieties produced good yields on infested soil where susceptible varieties were entirely destroyed. It was found, however, that as a general rule the resistant varieties yielded slightly less than the susceptible ones when they were grown side-by-side on non-infested soil. Because of this difference, it is recommended that the susceptible varieties be planted in non-infested soil and careful examination be made for the disease each year. As soon as the disease appears, resistant varieties should be planted.

Any of the following mid-season or kraut varieties are recommended for yellows-infested fields: Racine Market, Early Copenhagen Resistant, Marion Market, Glory Yellows Resistant, Globe, All Head Select, and Wisconsin All Season.

Of the earlier varieties, Jersey Queen is excellent from a resistance standpoint but does not yield heavily, while Resistant Golden Acre and Detroit Resistant yield very well even tho the resistance is not so good.

None of the late varieties tested, entirely meets the needs of New York growers. For not too exacting markets, Wisconsin Ballhead with its almost complete resistance and the Wisconsin Hollander types with their lower resistance will serve and produce commercial yields. The Resistant Red Hollander is recommended also for special markets.

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INTRODUCTION

CABBAGE yellows was first discovered on plants near Albany, N. Y., in 1895 by E. F. Smith of the United States Department of Agriculture. By 1915, the disease was present in many fields and occurred in the important market garden areas on Long Island and in the kraut region of Ontario County. Since then the disease has spread to other fields until at present it seriously threatens the cabbage industry. The disease is of particular concern, for New York is the leading cabbage-producing state in the Union. Several other states produce more early cabbage, but New York is outstanding in production of mid-season and late crops.

The annual production in this State for the period 1927–1936 was 292,600 tons from the 33,320 acres in commercial plantings. About 21,190 of the acres were planted to late varieties, 10,410 to mid-season varieties, and only 1,720 (on Long Island) to early cabbage. The average production from these areas was 179,300 tons of late, 96,500 tons of mid-season, and 16,800 tons of early cabbage. On the average, 58,700 tons from 6,280 acres were made into sauerkraut.

The gross return to the farmers of the State averages about 3½ million dollars a year. This return varies from 4½ to 1½ million dollars a year because of the extreme variations in production from year to year. The area planted ranges from 25,000 to 43,000 acres. The yield per acre fluctuates with the character of the growing season so that in some years the total yields may be abnormally high. For example, in 1938 the estimated yield was 147,300 tons of mid-season cabbage from 9,820 acres and 219,400 tons of late cabbage from 19,950 acres.

Altho cabbage is grown in almost every county of the State, most of the commercial crop is produced in about 10 principal areas. These areas, shown on the map in Fig. 1, include Erie County;

FIG. 1.—COMMERCIAL CABBAGE-GROWING AREAS AND PRESENCE OF CABBAGE YELLOWS IN NEW YORK STATE.

Commercial production dotted; one dot, 50 acres. Areas of heaviest infestation within heavy lines. (Data on acreage distribution from Cornell University Agr. Exp. Sta. Bul. 704.)

Niagara, Orleans, Monroe, and Wayne counties; Genesee County; Livingston, Ontario and Yates counties; Seneca County; Cayuga and Onondaga counties; Cortland and Cayuga counties; Madison and Chenango counties; Albany and Rensselaer counties; and Nassau and Suffolk counties on Long Island.

Because the industry in certain localities already is threatened by the yellows disease, growers should become acquainted with the nature of the disease and the possible control measures that have been devised. There are on the market seed stocks of several disease-resistant varieties of the early, mid-season, and late types. These have been tested on infested as well as on disease-free soil alongside the ordinary susceptible varieties now being grown. The data obtained on their productivity, disease resistance, and general characteristics are presented in this bulletin.

THE DISTRIBUTION OF CABBAGE YELLOWS IN NEW YORK

As mentioned above, the disease was present in Albany County in 1895 and was known to be present on Long Island in 1914 and in Ontario County in 1915. Since then it has spread extensively in the market gardening areas along Lake Erie and Lake Ontario.[1] Today the disease is very general in the kraut sections of Ontario County and in the general cabbage-growing areas of Genesee and Monroe counties, in the Tully Valley of Onondaga County, along the Hudson in Albany and Rensselaer counties, and on the western end of Long Island. The areas of heaviest infestation are shown in Fig. 1. The disease has not yet been observed in Cortland and Chenango counties.

The severity of the disease varies in different soils and in different seasons. Losses of 60 per cent were reported for several fields in Nassau County as early as 1923 and losses of 50 per cent for Albany County by 1926. In 1932, about 3 per cent of the 6,000 acres planted to cabbage in Ontario County were infested. At present a crop cannot be produced on severely infested areas in many of the regions from which the disease has been reported.

THE CAUSE AND SYMPTOMS OF YELLOWS

Yellows is caused by a fungus known as *Fusarium conglutinans* that lives in the soil. The fungus may live for many years on decaying plant parts and refuse once it becomes established in the soil. It is not reported to be carried on the seed. The disease-producing organism enters the plant thru the root system and grows into the leaves. Cabbage, cauliflower, Chinese cabbage, kohlrabi, kale, broccoli, and brussels sprouts are known to become infected. Since in infested soil the fungus does not need cabbage plants for its host crop, rotation is not effective as a means of control. The pathogen is spread from infested to non-infested areas by pieces of diseased plant tissue, infested soil or fungous spores being carried from field to field by wind, running water, implements, or men and animals. The dry lower infected leaves drop from diseased plants and may be blown about. Plowing infested fields as soon as possible after harvest will prevent some spread by burying plant parts. Another

[1]Early records of distribution obtained from Professor Charles Chupp of the Cornell University Extension Service.

common means of spread is by the planting of infected seedlings grown in an infested seedbed. To prevent spread by this means the grower must know the source of his plants to be sure they have come from a seedbed free from disease. The spread of the disease may be delayed by observing routine precautions about communication from infested to non-infested fields. Tools should be thoroly cleaned and preferably washed with a 5 per cent formaldehyde solution before going into non-infected fields.

Even with the most stringent of precautions the fungus very often reaches new fields. During the first year it infects only a few plants, and during the second year larger, irregularly circular areas with diseased plants may be observed because the fungus has been spread into adjacent soil during cultivation. In the course of a few more cabbage plantings the disease-producing organism is gradually spread thruout the field. When the entire field becomes infested it is no longer possible to grow the ordinary susceptible cabbage varieties. The grower should learn to recognize the general symptoms and to be on the lookout for them, because it is necessary to detect the disease when it first appears if serious losses are to be avoided in future plantings. After the disease has been once observed in a field a record should be made of the fact, and if infection is severe, in the future only yellows-resistant varieties should be planted in this field.

Young plants have a lifeless yellowish-green color shortly after they become infected. Later the leaves wilt, dry up, and turn brown. In severe cases the plant may be killed within 2 weeks after setting. However, many plants continue to grow for a month or more but have a sickly yellowish color from which the disease secures its common name. Frequently, only one side of the plant is infected and the remainder of the plant makes a lop-sided growth. On older plants the outer leaves dry up and fall off. The interior of diseased stems have darkened water-conducting vessels that can be seen by cutting across the base of the stem.

THE USE OF RESISTANT VARIETIES AS A CONTROL

After the fungus has become established in a field, the only control measure that is really effective is to plant resistant varieties (Fig. 2). Several of these are available. In order to learn more about their suitability to New York conditions several of them have been grown in different sections of the State to gain information on their market type

FIG. 2.—A SEVERELY INFESTED FIELD.

Planted on the left to a susceptible Copenhagen variety and on the right to a resistant Marion Market strain. All plants of the susceptible variety have been killed. (Phelps, N. Y.)

and time of maturity as well as on their productivity and disease resistance. The varieties tested and their general characteristics are given below.

EARLY VARIETIES TESTED

The following resistant strains were included in the early group: Jersey Queen, Resistant Golden Acre, and Detroit Resistant. The non-resistant varieties used as checks included two strains of Golden Acre, Peerless (a Golden Acre type), and Copenhagen Market.

Jersey Queen is a selection from Jersey Wakefield with a small, compact, pointed head. The leaves are smooth and dark green. It normally matures in from 60 to 70 days.

Resistant Golden Acre, a resistant selection from Golden Acre, has a spherical head and matures in 60 to 70 days under favorable conditions in northern New York.

Detroit Resistant conforms in type with the Resistant Golden Acre.

The non-resistant Golden Acre is an early-maturing strain differing slightly from the earlier types of Copenhagen Market. It is

spherical and matures in 60 to 70 days under normal northern New York growing conditions.

The Peerless apparently is a strain of Golden Acre as it has similar characteristics. It matures in the same number of days.

The Copenhagen Market was one of the smaller, earlier types, maturing in 60 to 70 days.

MID-SEASON VARIETIES TESTED

Tests with resistant mid-season varieties included the folowing: Racine Market, All Head Select, Early Copenhagen Resistant, three strains of Marion Market, Glory Yellows Resistant, two strains of Globe, and two strains of Wisconsin All Season. For comparison, the non-resistant types of Early Seneca, Copenhagen Market (second early), and six strains of Glory were used.

Racine Market, a resistant selection from a Copenhagen Market strain, has round, solid heads with a gray-green leaf color. It matures in 65 to 75 days. This strain falls between the early and mid-season types and is suitable for market and early kraut.

All Head Select, a selection from All Head Early, matures in from 70 to 80 days. It produces large firm heads that are flat to slightly rounded across the top. They are tender and excellent for table use and for early sauerkraut.

Early Copenhagen Resistant has a spherical, compact head with a blue-green foliage. It resembles Marion Market but matures slightly earlier, in 70 to 80 days under normal northern New York growing conditions. A similar strain appears on the market under the name of Copenhagen Market Yellows-resistant.

Marion Market, a selection from Copenhagen Market maturing in 75 to 85 days, has large spherical, compact heads with a blue-green foliage.

The Glory Yellows Resistant matures in from 75 to 85 days and has large spherical heads somewhat similar to Marion Market.

The resistant Globe is a selection from Glory of Enkhuizen and is somewhat later than the Marion Market strains, maturing in 80 to 90 days. Globe has a spherical, uniform, compact head with a small core.

Wisconsin All Season, a selection from All Seasons, is a late-maturing, semi-flat type used for fall market and the late kraut pack. It matures in 100 to 110 days. Wisconsin All Season is extremely hardy, a heavy yielder, and will withstand drought and insect infestation better than the other types. It is reported to show a greater resistance to cabbage mosaic, a virus disease.

The Early Seneca non-resistant strain used as one of the checks is earlier than the Glory and Early Copenhagen types used in the tests. It has solid, spherical heads, maturing in 70 to 80 days.

The Early Copenhagen non-resistant strain matured in 85 to 90 days and had large, spherical, solid heads.

Glory of Enkhuizen is one of the most popular non-resistant, mid-season or kraut types with large, spherical heads maturing in 95 to 100 days. Some differences were noted in the various strains tested.

LATE VARIETIES TESTED

Tests with the resistant late or Danish varieties of cabbage included Wisconsin Ballhead, Bugner, two strains of Wisconsin Hollander, two strains of Wisconsin Hollander No. 8, and Resistant Red Hollander. The non-resistant checks included nine strains of Danish Ballhead and individual strains of the following: Penn State Ballhead, Amager Short Stem, Amager Medium Stem, and Amager Balloon.

Resistant Wisconsin Ballhead, a selection out of Danish Ballhead, has a small, round, solid, compact head with blue-green foliage. It is very uniform in type and maturity. It matures in 85 to 95 days, being earlier than the non-resistant Danish Ballhead types.

Bugner is a late cabbage of the Danish type grown for special markets. The heads are solid, some slightly flattened, with dark green leaves. The green leaf color is retained in storage. It matures in 95 to 105 days.

The strains of Wisconsin Hollander and Wisconsin Hollander No. 8 are selections from Danish Ballhead. The heads are round to ovate, being slightly flattened across the top and have a blue-green color. They are not as uniform in maturity as the Wisconsin Ballhead. The various types mature in 100 to 110 days.

Resistant Red Hollander is a spherical, late, uniform cabbage with a purple-red foliage. Heads are small, solid, and compact and mature in 110 to 120 days.

The nine strains of non-resistant Danish Ballhead used were mostly of the globular to ovate head types. Some had more flattened heads than others, and some had short while others had intermediate stems. The maturity varied from 125 to 135 days under normal conditions.

Penn State Ballhead is a short stem variety with a medium sized head, slightly flattened, and with a bright green color. The maturity is around 135 days.

The Amager strains tested are not commonly grown in northern New York. The Amager short and medium stemmed strains had more or less flattened heads, while the Balloon strain had an elongated head. The maturity was around 135 days.

There are several questions that need to be answered before sound recommendations can be made about using any of these varieties. Are the commercial seed stocks reliable? Do the varieties stand up under different growing conditions? Do the resistant varieties produce as well as the susceptible ones now in use? The latter question is of particular interest because if they produce as well as suscep-

tible varieties they should be used exclusively without waiting for the disease to show up, but if they yield less then they should be planted only in infested fields.

EXPERIMENTAL METHODS

In conducting the experiments it was considered necessary to test the resistant varieties in several localities because the difference in cultural methods may affect the results obtained. Replicated experimental plantings as well as commercial field tests were made on different soil types in 1937, 1938, and 1939. The tests in 1937 were made on a non-infested Dunkirk silty clay loam at Geneva and on the following infested soils: Medium clay loam at Hall; fine sandy loam at Phelps; sandy loam at Penfield; and Haven loam at Glen Head and at Flushing on Long Island. The 1938 tests were all on non-infested soil. They were placed on a Dunkirk silty loam at Geneva, a light clay loam (high organic matter) at Hall and Stanley, a light clay loam at Hall and Geneva, and a medium clay loam (shale) at Gorham. The 1939 test plantings were made on the following infested soils: A medium clay loam at Seneca Castle and Flint and a fine sandy loam at Phelps.

The replicated tests were made with rows of 25 plants, exclusive of buffer plants at each end, of each strain randomized five times thruout the area planted. This gave 125 plants of each for records. By scattering the rows of 25 plants at random thruout every plat all possible variations in soil and other growing conditions were taken into consideration. The commercial field tests were made in 1/30 to 1/10 acre plantings of the various varieties. The plantings were in growers' cabbage fields on various soil types. The tonnage per acre in all tests was calculated by taking weights of commercial cabbage heads produced on measured plats. The actual field yield of normal heads was thereby obtained.

COMPARATIVE YIELDS ON NON-INFESTED SOILS IN 1937 AND 1938

Replicated and commercial field test plantings on non-infested soils were made in various soil types in the Geneva and Hall regions. These tests were run to determine just what each resistant variety on the market would yield in comparison with the commonly planted non-resistant ones. All cabbage yellows-resistant varieties in the early, mid-season, and late groups then on the market were planted

along with various non-resistant strains. Since mid-season and late varieties are most commonly grown in this State, tests with strains of these were run more in detail.

The results of these tests are presented in Tables 1 and 2. Yields in 1937 were low because of the extreme dry season, but they were comparable to those obtained by growers. The 1938 season was wetter with more normal yields (Fig. 3). All varieties marked with

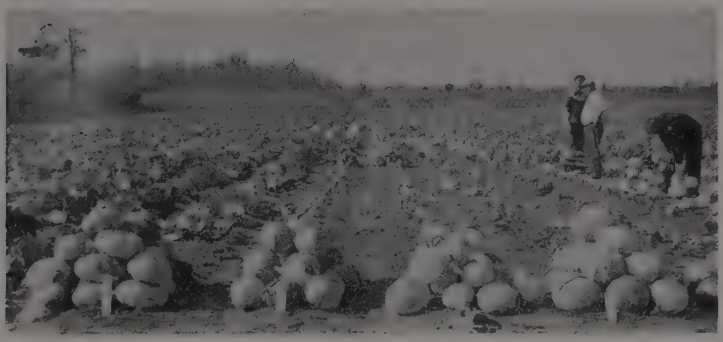

FIG. 3.—REPLICATED PLATS ON NON-INFESTED SOIL.

From left to right, cabbage of the varieties Wisconsin All Season, Wisconsin Ballhead, Wisconsin Hollander No. 8, and Bugner produced from 25 plants in replicated plats on non-infested soil at Hall, N. Y., 1938.

an asterisk in the tables are yellows-resistant. Those not so marked are non-resistant strains commonly planted on healthy soil.

REPLICATED TESTS

Replicated tests on non-infested soil were run in 1937 and 1938 at Geneva on a Dunkirk silty clay loam and also in 1938 at Hall on a light clay loam (high organic matter). The results of the tests are summarized in Table 1. Representatives of the early, mid-season, and late varieties were included as discussed below.

Early cabbage.—According to the data presented in Table 1 for 1937, the pointed Jersey Queen was the lowest yielder of all. Resistant Golden Acre with 8.21 tons per acre yielded almost as well as the two non-resistant Golden Acre strains and somewhat better than the non-resistant Copenhagen Market. The Detroit Resistant yielded somewhat less than both the non-resistant types.

TABLE 1.—YIELDS OF YELLOWS-RESISTANT AND SUSCEPTIBLE VARIETIES OF CABBAGE PLANTED ON NON-INFESTED SOIL IN REPLICATED PLANTINGS IN 1937 AND 1938.†

VARIETY	1937, DUNKIRK SILTY CLAY LOAM, GENEVA, PLANTING DISTANCE 18 IN. AND 24 IN.‡		1938, DUNKIRK SILTY CLAY LOAM, GENEVA, PLANTING DISTANCE 24 IN.		1938, LIGHT CLAY LOAM (HIGH ORGANIC MATTER) HALL, PLANTING DISTANCE 19 IN.	
	Av. weight per head, lbs.	Tons per acre	Av. weight per head, lbs.	Tons per acre	Av. weight per head, lbs.	Tons per acre
Early						
Jersey Queen*	1.09	5.30	—	—	—	—
Resistant Golden Acre*	1.74	8.21	—	—	—	—
Detroit Resistant*	1.59	7.32	—	—	—	—
Golden Acre, strain 1	1.81	8.68	—	—	—	—
Golden Acre, strain 2	1.71	8.29	—	—	—	—
Copenhagen Market	1.70	8.06	—	—	—	—
Mid-Season (Domestic or Kraut)						
Racine Market*	2.92	10.54	2.77	9.65	5.00	22.80
Early Copenhagen Resistant*	3.63	12.77	6.00	21.70	6.90	31.70
All Head Select*	2.50	12.09	4.35	14.40	5.70	25.85
Marion Market, strain 1*	3.26	11.73	—	—	—	—
Marion Market, strain 2*	3.36	12.19	4.65	17.00	6.05	27.55
Marion Market, strain 3*	3.18	11.55	—	—	—	—
Globe, strain 1*	2.96	10.65	4.90	17.10	6.35	28.90
Globe, strain 2*	3.74	13.35	—	—	—	—
Wis. All Season, strain 1*	3.64	12.92	6.15	21.75	6.85	30.85
Wis. All Season, strain 2*	3.72	12.86	—	—	—	—
Early Seneca	—	—	3.75	12.85	6.15	27.20
Glory, strain 1	3.92	14.22	7.09	25.72	6.56	28.71
Glory, strain 2	—	—	5.72	20.16	6.76	30.63
Glory, strain 3	—	—	7.02	24.54	6.85	30.80
Glory, strain 4	—	—	6.28	22.28	6.48	28.49
Glory, strain 5	—	—	7.10	25.00	6.73	30.29
Glory, strain 6	—	—	6.70	23.44	7.53	33.36
Late (Danish)						
Wis. Ballhead*	2.90	10.80	3.70	12.65	4.45	20.15
Bugner*	2.85	10.01	5.55	19.75	4.85	21.80
Wis. Hollander*	1.90	6.96	—	—	—	—
Wis. Hollander No. 8, strain 1*	2.38	8.68	4.70	16.75	4.75	21.65
Wis. Hollander No. 8, strain 2*	2.29	7.46	—	—	—	—
Red Hollander*	1.60	5.80	—	—	—	—
Danish Ballhead, strain 1	2.93	10.91	5.19	18.52	4.89	22.15
Danish Ballhead, strain 2	—	—	4.45	15.88	4.09	18.98
Danish Ballhead, strain 3	—	—	5.19	17.85	4.82	17.24
Danish Ballhead, strain 4	—	—	5.19	17.85	5.15	22.32
Danish Ballhead, strain 5	—	—	5.35	19.00	5.16	23.92
Danish Ballhead, strain 6	—	—	5.19	18.63	5.02	23.15
Danish Ballhead, strain 7	—	—	5.54	14.89	4.57	21.02
Danish Ballhead, strain 8	—	—	5.72	20.00	5.69	26.41
Danish Ballhead, strain 9	—	—	5.03	18.14	5.00	23.34
Penn State Ballhead	—	—	5.75	20.15	4.95	22.75
Amager Short Stem	—	—	4.68	16.74	4.04	17.07
Amager Medium Stem	—	—	4.61	—	4.87	21.53
Amager Balloon	—	—	3.38	11.18	4.47	20.41

*Resistant varieties. †1937 was a dry year; 1938 a normal year for rainfall.

No tests of early types were run in 1938. The planting distance for all early varieties was 18 inches.

Mid-season cabbage.—In the 1937 test on Geneva Dunkirk silty clay loam, Racine Market, a new market and early kraut cabbage not released until 1938, did exceptionally well for an earlier strain with a yield of 10.54 tons. It yielded well in the two 1938 tests. Of the spherical varieties, Early Copenhagen Resistant, except in the 1937 test, outyielded the other resistant strains. In the Hall test for 1938 it yielded equally as well as the average of the non-resistant Glory strains. The flat resistant variety, All Head Select, did not yield as well as the non-resistant Glory strains. Little difference was shown in yield of the three strains of Marion Market tested in 1937. All yielded somewhat less than the Glory. In the 1938 tests the Marion Market planted on the Geneva soil yielded 6 tons less per acre than the average Glory and on the Hall soil not quite 3 tons less. In 1937, strain 2 of resistant Globe with a yield of 13.35 tons per acre outyielded all other resistant types but did not yield as well as the non-resistant Glory that produced 14.22 tons per acre. In the 1938 tests on both soil types the one strain of Globe used yielded well but somewhat less than the average of the non-resistant Glory strain tested. In 1937 the flat Wisconsin All Season yielded about a ton less than the Glory, while in the 1938 Hall planting it yielded equally as well as the average of the non-resistant Glory strains. In the 1937 test the non-resistant Glory strain with a yield of 14.22 tons to the acre outyielded all resistant strains by from 1 to 3.5 tons. Yields of the six non-resistant Glory strains used in the 1938 Geneva tests ran from 20.16 to 25.72 tons per acre with an average of 23.5 tons per acre. In the Hall test on better cabbage soil, the yields ran from 28.49 to 33.36 tons per acre with an average of 30.35 tons. The non-resistant Early Seneca in both of these tests yielded, respectively, 12.85 and 27.2 tons to the acre.

Late cabbage.—In 1937 the resistant Wisconsin Ballhead strain with 10.8 tons to the acre yielded equally as well as the non-resistant Danish Ballhead with 10.91 tons to the acre. In the 1938 tests with yields of 12.65 tons at Geneva and 20.15 tons per acre at Hall, Wisconsin Ballhead yielded 5 and 2 tons less per acre, respectively, than the average of the nine non-resistant Danish Ballhead strains. Bugner in all tests yielded somewhat less than the better non-resistant Danish Ballhead strains. In the 1937 tests, Wisconsin Hollander and Wisconsin Hollander No. 8 yielded from 2 to 4 tons less than

the non-resistant Danish Ballhead. In 1938, on Dunkirk silty clay loam at Geneva, resistant Wisconsin Hollander No. 8 yielded 16.75 tons per acre as compared with an average of 17.85 tons for the nine strains of non-resistant Danish Ballhead. On the lighter soil at Hall the yield was 21.65 tons compared with an average of 22.05 tons for the nine Danish Ballhead strains (Fig. 3). The resistant Red Hollander tested in 1937 yielded much less than the non-resistant Danish Ballhead.

COMMERCIAL FIELD TESTS

In addition to the replicated tests on yields, plantings of the various resistant and non-resistant strains were made along with general farm plantings on different non-infested soil types. The results of these tests are presented in Table 2. No trials were made with representatives of the early group.

Mid-season cabbage.—In all field plantings Early Copenhagen Resistant, Marion Market, and Globe yielded equally well. On the light clay loam plantings of 1938 at Hall, all three of these resistant types yielded more than the Glory non-resistant type. In the 1/23 acre Hall field planting, non-resistant Early Seneca outyielded all others with 23.92 tons to the acre. In the Stanley and Gorham plantings, Glory outyielded all other types by some 3 tons and 2 tons, respectively. Wisconsin All Season gave consistently good yields on all farms, yielding in some cases better than the non-resistant Glory.

Late cabbage.—The field plantings of Danish cabbage in 1938 were all made in the Rochester region.[2] These tests gave similar results to those obtained in the replicated plantings. The yellows-resistant Wisconsin Ballhead in every planting yielded from 3.5 to 5.5 tons less per acre than the best non-resistant Danish strain tested. The Wisconsin Hollander strains did somewhat better but still yielded from 2 to 6 tons less than the non-resistant checks.

COMPARATIVE YIELDS ON INFESTED SOILS IN 1937 AND 1939

The seasons of 1937 and 1939, being dry and hot, were favorable to severe disease production on heavily infested soils. In the foregoing pages data have been presented giving the comparative yields

[2]Plantings were made in cooperation with Mr. Ralph Palmer of the Monroe County Farm Bureau.

TABLE 2.—YIELDS OF YELLOWS-RESISTANT AND SUSCEPTIBLE VARIETIES OF CABBAGE PLANTED ON NON-INFESTED SOIL IN COMMERCIAL FIELD PLANTINGS IN 1937 AND 1938.†

VARIETY	1937, PLANTING DISTANCE 24 IN., DUNKIRK SILTY CLAY LOAM, GENEVA, 1/10 ACRE, TONS PER ACRE	1938, PLANTING DISTANCE 20 IN.				
		Light clay loam, Hall, 1/14 acre, tons per acre	Light clay loam, Hall, 1/23 acre, tons per acre	Light clay loam, Geneva, 1/25 acre, tons per acre	Light clay loam (high organic matter), Stanley, 1/28 acre, tons per acre	Medium clay loam (shale), Gorham, 1/30 acre, tons per acre
Mid-Season (Domestic or Kraut)						
Early Copenhagen Resistant*	——	24.83	20.21	17.50	22.96	18.19
Marion Market, strain 1*	8.66	23.57	20.44	20.68	22.42	——
Marion Market, strain 2*	——	——	——	——	——	17.51
Globe*	9.98	23.66	21.83	19.16	——	——
Wis. All Season*	13.87	24.35	21.02	14.39	22.42	15.06
Early Seneca	——	——	23.92	——	——	——
Glory, strain 1	12.23	——	——	22.82	——	——
Glory, strain 2	——	——	——	——	25.74	——
Glory, strain 3	——	22.43	19.92	——	——	20.10
Late (Danish)						
	Lyons silt loam, Webster, 1/9 acre tons per acre	Ontario loam, Pittsford, 1/20 acre tons per acre		Schohaire silt loam, Churchville, 1/12 acre tons per acre		Gravelly loam, Hilton, 1/11 acre tons per acre
Wis. Ballhead*	7.77	21.12		15.30		8.26
Bugner*	——	27.25		——		——
Wis. Hollander*	8.51	——		15.00		7.41
Wis. Hollander No. 8*	9.15	20.60		17.10		6.09
Danish Ballhead, strain 1	13.47	26.48		19.10		11.79
Danish Ballhead, strain 2	10.14	26.67		16.00		——

*Resistant varieties.
†1937 was a dry year; 1938 a normal year for rainfall.

of resistant and non-resistant varieties grown on healthy soil. In order to determine the yields these varieties would give when planted on severely infested soils, replication and commercial field test plantings were made (Fig. 4). The data obtained in each test are

FIG. 4.—REPLICATED TEST PLANTING ON INFESTED FINE SANDY LOAM SOIL.

Note rows of non-resistant varieties scattered thru planting with practically 100 per cent loss. Resistant varieties stand out healthy. (Phelps, N. Y., 1937.)

presented in Table 3. Yields for both years were low because of the dry seasons, but excellent comparative data were obtained for strains within each test.

In 1937, replicated trial plantings on sick soil of all groups were made on a medium clay loam at Hall, a fine sandy loam at Phelps, a sandy loam at Penfield, and on Haven loam soil types at Glen Head and Flushing in Nassau County, Long Island. Commercial field test plantings were made in 1937 on a medium clay loam infested soil at Hall and in 1939 on a light clay loam infested soil at Seneca Castle. The Hall, Phelps plat 1, Long Island plat 1, and Seneca Castle plats had a uniform, heavy soil infestation. The soil infestation was not so uniform in the other plantings.

REPLICATED TESTS

The replicated test plantings consisted of 20 to 25 plants in rows replicated five times in each plat. Early, mid-season, and late strains were under test with the results given below.

Early cabbage.—For an extremely dry season good yields were obtained in 1937 in the replicated variety planting on infested light clay loam soil at Hall. Jersey Queen gave a yield of 4.27 tons per acre. The estimated yields of 8.71 tons per acre for Resistant Golden Acre and 7.26 tons per acre for Detroit Resistant are considered normal and compare favorably with the yields obtained on healthy soils. The non-resistant strains, Golden Acre and Copenhagen Market, planted in the same infested soil yielded only 0.27 and 1.74 tons, respectively.

Mid-season cabbage.—For the dry years of 1937 and 1939 when all average farm yields were low, the resistant varieties of domestic cabbage planted on various infested soil types gave surprisingly good yields. The data are presented in Table 3. The best yields were obtained on the medium clay loam soil at Hall and the sandy loam planting at Penfield. The lowest yields were obtained on the fine sandy loam soil at Phelps. While the rainfall at Hall and Phelps was not much different, the medium clay loam at Hall retained more moisture than the sandier soil at Phelps. More rain was obtained in the Penfield region which accounted for the better yield.

Except for the semi-early Racine Market and Wisconsin All Season, no real difference in yield was obtained between the various commonly planted resistant domestic strains in each separate replicated planting. All yielded well on the heavily infested soil. The Racine Market used in 1937 was from a test sample of seed as this strain had not yet been placed on the market. In the Hall plat a yield of 8.94 tons per acre was obtained. On the fine sandy loam plat at Phelps it yielded 7.42 tons per acre. The latter field was very dry. The flat Wisconsin All Season yielded more on two of the replicated plats. The non-resistant variety Glory, planted as a check in all tests, naturally gave very poor yields on the infested soil. At Hall a yield of 2.12 tons was obtained, while at Phelps only 0.74 ton was secured. The Penfield plat was not so uniformly infested, but even there a yield of only 3.58 tons per acre was obtained as compared with 13.4 tons for the Early Copenhagen Resistant and 18.84 tons for one strain of Wisconsin All Season. The disease was most severe in the Phelps fine sandy loam plat. The plat was located

TABLE 3.—YIELDS OF YELLOWS-RESISTANT AND SUSCEPTIBLE VARIETIES OF CABBAGE PLANTED ON INFESTED SOIL IN REPLICATED AND COMMERCIAL FIELD PLANTINGS IN 1937 AND 1939.†

VARIETY	REPLICATED PLANTINGS, 1937						COMMERCIAL FIELD PLANTINGS	
	Medium clay loam, Hall, planting distance 24 in.		Fine sandy loam, Phelps, planting distance 24 in.		Sandy loam, Penfield, planting distance 18 in.		1937, medium clay loam, Hall, planting distance 24 in., 1/20 acre, tons per acre	1939, medium clay loam, Seneca Castle, planting distance 20 in., 1/27 acre, tons per acre
	Av. weight per head, lbs.	Tons per acre	Av. weight per head, lbs.	Tons per acre	Av. weight per head, lbs.	Tons per acre		
				Early				
Jersey Queen*	1.34	4.27	——	——	——	——	——	——
Resistant Golden Acre*	2.64	8.71	——	——	——	——	——	——
Detroit Resistant*	2.38	7.26	——	——	——	——	——	——
Golden Acre	0.37	0.27	——	——	——	——	——	——
Copenhagen Market	1.23	1.74	——	——	——	——	——	——

Mid-Season (Domestic or Kraut)								
Racine Market*	2.62	8.94	2.01	7.42	——	——	9.06	——
Early Copenhagen Resistant*	3.22	11.61	1.90	7.45	2.80	13.40	12.04	8.31
All Head Select*	——	——	——	——	——	——	——	6.45
Marion Market, strain 1*	3.74	12.92	1.86	7.28	——	——	11.85	——
Marion Market, strain 2*	2.93	10.62	——	——	——	——	——	6.14
Marion Market, strain 3*	——	——	——	——	——	——	——	8.17
Glory Yellows Resistant*	——	——	——	——	——	——	——	6.88
Globe, strain 1*	2.95	10.54	1.86	7.23	——	——	11.28	6.62
Globe, strain 2*	3.49	12.05	2.22	8.01	——	——	9.65	——
Wis. All Season, strain 1*	4.24	14.94	2.36	7.45	3.94	18.82	14.80	8.07
Wis. All Season, strain 2*	——	——	——	——	3.87	18.84	——	——
Glory	4.34	2.12	1.78	0.74	4.65	3.58	1.86	0.28
Copenhagen Market (2d early)	——	——	——	——	——	——	——	0.05
Late (Danish)								
Wis. Ballhead*	2.32	8.59	——	——	2.97	14.08	9.88	5.17
Bugner*	——	——	——	——	3.62	16.64	——	5.47
Wis. Hollander, strain 1*	——	——	——	——	2.66	13.16	——	——
Wis. Hollander, strain 2*	——	——	——	——	2.55	12.34	——	——
Wis. Hollander No. 8, strain 1*	——	——	——	——	2.62	12.53	——	5.32
Wis. Hollander No. 8, strain 2*	——	——	——	——	3.33	15.00	——	5.17
Red Hollander Resistant*	——	——	——	——	1.49	7.26	——	——
Danish Ballhead	——	——	——	——	1.86	2.03	——	0.87

*Resistant varieties.
†Both years dry with low yields.

in a field subject to drying out and so exposed to the sun that high soil temperatures resulted.

Late cabbage.—The late Danish varieties were tested in 1937 only in the replicated plat on the sandy loam moderately infested soil at Penfield. The resistant strains yielded well with 14.08 tons per acre for Wisconsin Ballhead, 16.64 tons for Bugner, 12.34 and 13.16 tons for Wisconsin Hollander, 12.53 and 15.00 tons for Wisconsin Hollander No. 8, and 7.26 tons for the resistant Red Hollander. The non-resistant Danish Ballhead planted as a check yielded only 2.03 tons on the same sick soil.

COMMERCIAL FIELD TESTS

In 1937 and 1939 field plantings were made of the mid-season and late varieties on heavily infested soils at Hall and Seneca Castle. The results are summarized in Table 3. Since the growing seasons were hot and dry, severe disease conditions existed. This was especially true of the Seneca Castle planting of 1939 that was made on a southerly slope exposed to the sun.

Mid-season cabbage.—In spite of the presence of severe disease in the Glory non-resistant check that yielded only 1.86 tons in the Hall field and 0.28 ton in the Seneca Castle field, the resistant domestic strains yielded well for a dry year when between 5 and 10 tons per acre were normal farm yields. In these field tests the various resistant varieties yielded in order approximately the same as they did in the detailed replicated tests. In both fields little difference in yields was shown between the better strains of Early Copenhagen Resistant, Marion Market, and Globe. The flat Wisconsin All Season type gave somewhat larger yields.

Late cabbage.—In 1939 on the severely infested Seneca Castle field both Wisconsin Ballhead and Wisconsin Hollander No. 8 yielded 5.17 tons per acre, while the non-resistant Danish Ballhead used as a check only gave a yield of 0.87 ton. Wisconsin Ballhead in the 1937 planting on the yellows sick soil at Hall yielded 9.88 tons to the acre.

PERCENTAGE OF DISEASE PRESENT ON INFESTED SOIL IN 1937 AND 1939

Cabbage yellows in New York State already is widely distributed on various soil types and in different climatic regions. In order to determine whether any difference in resistance exists under these various growing conditions, the test plantings made in 1937 and

1939 were widely distributed so as to take into consideration various cabbage cultural conditions.[3] Replicated and commercial field tests were made of early, mid-season, and late resistant commercial strains on the market in comparison with the non-resistant varieties planted commercially. The results of the tests are given in Table 4. The Hall, Phelps plat 1, Long Island plat 1, and Seneca Castle plats had a uniform, heavy soil infestation. The soil infestation was not so uniform in the other plantings.

Early cabbage.—The resistant early cabbage types were tested in 1937 on a medium clay loam at Hall. In this replicated test, 18.5 and 11.1 per cent of the plants of Resistant Golden Acre and Detroit Resistant, respectively, were diseased, while plants of the non-resistant Golden Acre check were 100 per cent diseased. Jersey Queen developed no disease in the one test planting made. In the different soil type plantings at Hall and Phelps and on Long Island[4] the non-resistant Golden Acre and Copenhagen Market strains came down with from 46 to 100 per cent disease. The Peerless non-resistant, a strain of Golden Acre, developed 81 to 92 per cent disease in the Nassau County plats.

Mid-season cabbage.—In 1937 the new Racine Market, at that time not released, showed in the Hall replicated plat from 2.5 to 5.2 per cent disease and in the Phelps and Penfield plats 8.9 to 3.7 per cent disease. In the Nassau County heavily infested soil from 0 to 1.0 per cent disease developed. Early Copenhagen Resistant showed high resistance under all soil and climatic conditions. In the various replicated and field plats only from 0.05 to 5.84 per cent of the plants were infected. All Head Select developed from 1.00 to 6.46 per cent disease. Four strains of Marion Market were tested and differences in disease resistance were noted between the various strains. The best strain (No. 1) developed from 0 to 6.00 per cent disease, while the poorest strain (No. 3) showed from 8.00 to 15.91 per cent disease. In the 1939 field tests the Glory yellows-resistant, which appears to be a Marion Market type, developed from 4.61 to 7.33 per cent disease. The best strains of Globe had from 0 to 8.15 per cent disease, while one strain showed 16.3 per cent infection. From 0.61 to 8.25 per cent of the plants in the different Wisconsin All Season

[3]Plantings in the Seneca Castle, Flint, and Phelps regions were made in cooperation with Mr. Robert Boehlecke of the Ontario Farm Bureau.

[4]Plantings on Long Island were made in cooperation with the Nassau County Farm Bureau.

TABLE 4.—PERCENTAGE OF YELLOWS INFECTION IN DIFFERENT VARIETIES OF CABBAGE IN REPLICATED AND COMMERCIAL FIELD PLANTINGS IN SEVERAL LOCALITIES.

VARIETY	1937, DISEASE RECORDS, REPLICATED PLANTINGS							1939, DISEASE RECORDS, COMMERCIAL FIELD PLANTINGS		
	Medium clay loam, Hall		Fine sandy loam, Phelps		Sandy loam, Penfield, Plat 1	Haven loam, Long Island		Medium clay loam, Seneca Castle	Medium clay loam, Flint	Fine sandy loam, Phelps
	Plat 1	Plat 2	Plat 1	Plat 2		Plat 1, Glen Head	Plat 2, Flushing			
					Early					
Jersey Queen*	——	0.00	——	——	——	——	——	——	——	——
Resistant Golden Acre*	——	18.50	——	——	——	——	——	——	——	——
Detroit Resistant*	——	11.10	——	——	——	——	——	——	——	——
Golden Acre, strain 1	——	——	95.50	53.00	——	96.00	78.80	——	——	——
Golden Acre, strain 2	——	100.00	86.00	75.00	——	90.00	72.00	——	——	——
Peerless	——	——	——	——	——	92.00	81.00	——	——	——
Copenhagen Market	——	——	——	46.00	——	99.00	62.00	——	——	——

Mid-Season (Domestic or Kraut)											
Racine Market*	2.50	5.20	8.90	—	3.70	1.00	0.00	—	—	—
Early Copenhagen Resistant*	1.50	3.70	3.45	—	0.00	—	—	4.01	5.16	5.84
All Head Select*	—	—	—	—	—	3.05	1.00	6.46	5.41	—
Marion Market, strain 1*	3.70	—	2.20	6.00	—	0.00	1.00	—	—	—
Marion Market, strain 2*	2.40	3.70	7.00	3.00	—	—	—	1.53	10.54	—
Marion Market, strain 3*	—	—	—	8.00	—	—	—	13.53	15.91	—
Marion Market, strain 4*	—	—	—	—	—	—	—	—	—	1.07
Glory Yellows Resistant*	—	—	—	—	—	—	—	4.61	7.33	—
Globe, strain 1*	9.60	—	7.70	2.00	—	0.00	0.00	16.30	5.97	2.76
Globe, strain 2*	8.15	—	4.50	3.50	—	1.19	0.00	—	—	—
Wis. All Season, strain 1*	8.15	—	8.25	—	0.00	—	—	—	—	—
Wis. All Season, strain 2*	—	—	—	—	2.80	—	—	4.01	2.55	0.61
Early Seneca	95.00	—	—	—	—	—	—	—	—	—
Copenhagen Market (2d early)	—	—	—	—	—	93.00	51.00	99.70	—	61.02
Glory	92.60	—	93.25	58.00	34.25	92.00	73.00	96.93	95.86	75.38
Glory	—	—	—	—	88.90	—	—	—	80.00	—
Late (Danish)										
Wis. Ballhead*	2.20	—	0.00	3.00	0.90	0.00	0.00	1.53	2.02	0.00
Bugner*	—	—	—	—	6.50	—	—	54.15	16.46	—
Wis. Hollander, strain 1*	—	—	—	2.00	—	—	—	—	—	—
Wis. Hollander, strain 2*	—	—	—	—	8.35	—	—	—	—	—
Wis. Hollander No. 8, strain 1*	—	—	—	4.00	12.95	—	—	10.76	4.38	0.61
Wis. Hollander No. 8, strain 2*	—	—	—	1.00	12.95	—	—	20.61	—	—
Red Hollander Resistant*	—	—	—	2.00	6.50	—	—	—	—	—
Danish Ballhead, strain 1	—	—	—	—	12.05	92.00	30.00	—	—	—
Danish Ballhead, strain 2	—	—	—	—	97.20	—	—	—	—	—
Danish Ballhead, strain 3	—	—	—	—	—	—	—	91.69	51.06	—

*Resistant varieties.

strains were infected. The non-resistant checks, Glory, Early Seneca, and Copenhagen Market (second early) strains, developed from 34.25 to 99.7 per cent disease.

Late cabbage.—Wisconsin Ballhead in the late or Danish cabbage group showed a very high degree of resistance in all tests. In the replicated and field tests run during 1937 and 1939 on various soil types and in various regions it developed from 0 to 3.0 per cent disease. Bugner had 54.15 per cent disease in the worst infested plat and only 6.50 per cent in the least infested. The Wisconsin Hollander strains tested showed good resistance. In the replicated plats one had 2 per cent and the other 8.35 per cent disease. Wisconsin Hollander No. 8, a strain selected from the Wisconsin Hollander, possessed approximately the same amount of resistance. In the replicated plat tests one strain had from 4.00 to 12.95 per cent disease, while the other strain had from 1 to 12.95 per cent disease. Similar results were obtained in the field planting with from 0.61 to 10.76 per cent disease for one and 20.61 per cent disease for the second strain. The Resistant Red Hollander developed from 2.00 to 6.5 per cent disease. The Danish Ballhead non-resistant strains under test all showed practically no resistance when planted on heavily infested soil, developing from 12 per cent on slightly infested soil to 97.2 per cent on heavily infested soil.

DISCUSSION

Most of the yellows-resistant varieties of cabbage have been tested sufficiently so that tentative recommendations may be made regarding their use in New York. The experiments reported in this bulletin were made on several different soil types as well as in different kinds of growing seasons so that the varieties have been thoroly tested for disease resistance and productivity. Altho most of the experimental plantings were made near Geneva, Phelps, and Hall, sufficient plantings were made in the Rochester and Long Island areas to be certain that the varieties behaved similarly in different localities. It was possible to secure excellent yield records in 1938 when there was a favorable growing season. In addition, the hot, dry weather of 1937 and 1939 offered an excellent opportunity to study disease resistance since yellows is more severe in hot weather than in cool. Altho the yields were not very good in 1937 and 1939, they compared very favorably with commercial plantings in the same area.

Most of the commercial seed stocks of supposedly resistant varie-

ties were found to be reliable. Some of the strains, however, differed in their purity in regard to disease resistance. In the mid-season group, for example, several strains had 2 to 16 per cent susceptible plants among the resistant stock (Table 4). Those strains showing a higher percentage of infected plants should be selected further to eliminate the susceptible ones. There are a number of excellent mid-season strains such as Racine Market, Early Copenhagen Resistant, All Head Select, Marion Market, Globe, and Wisconsin All Season that are very pure. Of the early varieties Jersey Queen contained only resistant strains, but resistant Golden Acre and Detroit Resistant should be selected further for resistance. Wisconsin Ballhead in the late or Danish group possesses almost complete resistance developing none to 3 per cent diseased plants in severely infested fields. It is one of the most resistant varieties. Bugner has a resistance that is primarily dependent upon soil temperatures. During a hot and dry growing season somewhat over 54 per cent of the plants may become diseased. The same is true to a lesser extent of the strains of Wisconsin Hollander and Wisconsin Hollander No. 8 that may show 20 per cent diseased plants. The Resistant Red Hollander is highly resistant. In the late group, with the exception of Wisconsin Ballhead and possibly the Resistant Red Holander, there is need for further selection from a resistance standpoint.

In yellows-infested soil the resistant varieties yielded well, as may be seen from the figures in Table 3. These fields were severely infested as shown by the fact that susceptible varieties failed to produce a crop. Since the resistant varieties yielded so well, the question may be raised as to whether they should be planted on every farm regardless of whether the soil is infested. However, the data obtained on these varieties in non-infested soil show that they yielded slightly less than the susceptible varieties. For example, the data in Table 1 show that the Resistant Golden Acre produced in the dry year of 1937, 8.2 tons, while Golden Acre, the susceptible variety from which it was obtained, yielded 8.3 to 8.7 tons. The resistant Globe yielded 10.6 to 13.3 tons as compared with 14.2 tons for its susceptible parent variety, Glory. The same conclusions can be drawn from the higher yields obtained in 1938 which was a normal year for rainfall. In other words, if yellows is not present, the susceptible varieties should be preferred even tho the difference in yield is not very large.

The grower who uses susceptible varieties must always remember that he is running a distinct risk of the yellows fungus becoming established before he is aware of its presence. He should therefore examine his entire crop several times each season for yellows. As soon as definite infested areas are discovered, a record should be made of the fact and in the future only resistant varieties should be planted in that particular field.

There are a number of excellent yellows-resistant mid-season varieties on the market. The grower has a choice of both spherical and flat-headed types that will mature at different dates. Varieties of this group mature in 65 to 110 days, their order of maturity being Racine Market, All Head Select, Early Copenhagen Resistant, Marion Market, Glory yellows-resistant, Globe, and Wisconsin All Season. There is some room for improvement in productivity in this group, but many of the better strains yielded practically as much on non-infested soil as did the susceptible varieties.

Unfortunately, there is no late Danish type of cabbage that entirely meets the need of New York growers. The Wisconsin Ballhead is resistant but does not yield sufficiently nor have the desired storage qualities. It should be pointed out that the heads are small and the planting distance used in these experiments probably should have been decreased. Undoubtedly, a higher yield per acre would have been secured. Even so, it would not have yielded sufficiently to be comparable to the susceptible Danish types. Wisconsin Hollander strains do not possess complete resistance for 20 per cent of the plants may become diseased. While all store well, the various strains are regarded as being a little too coarse for most New York markets. Bugner is not sufficiently resistant to be recommended for general planting on heavily infested soil. The Red Hollander Resistant possesses a high degree of resistance but is a rather low yielder.

Among the early varieties, Jersey Queen is highly resistant and produces a firm pointed head but does not yield very much. However, here, as in the Wisconsin Ballhead, the distance used between plants was too far for maximum production per acre. The strains of Detroit Resistant and Resistant Golden Acre tested were not as pure for yellows resistance as Jersey Queen, but they did stand up well enough on infested soil to give good yields.

SUMMARY

Cabbage yellows is caused by a parasitic fungus that invades the roots of the plant and grows into the water-conducting tissue of the stem. Once the fungus becomes established in a field it will persist for many years regardless of the crop grown on the land.

Every effort should be made to prevent the spread of the fungus to non-infested fields. Ordinarily it is carried in on transplants grown in infested seedbeds or on tools, cabbage refuse, or particles of soil from infested fields. The grower should use only seedlings grown in non-infested seedbeds. In addition, care should be exercised in communicating between infested and non-infested fields. Tools used in infested fields should be thoroly cleaned and preferably washed with 5 per cent formaldehyde solution.

Once the fungus is introduced into a field resistant varieties should be planted. There are several good mid-season or kraut types on the market which are resistant. There are also several early and late varieties to choose from, but the late varieties now available are not entirely suitable for New York. Detailed information on the type of head produced by each variety, their time of maturity and general characteristics are given on pages 7 to 10. Information on disease resistance is given in Table 4 and on their productivity on infested and non-infested soil in Tables 1, 2, and 3.

The better strains of the resistant varieties produced good yields on infested soil where susceptible varieties were entirely destroyed. The yields obtained compared favorably with commercial production from susceptible varieties on non-infested soil in the same area. It was found, however, that as a general rule the resistant varieties yielded slightly less than the susceptible ones when they were grown side-by-side on non-infested soil. Because of this difference, it is recommended that the susceptible varieties be planted in non-infested soil and careful examination be made for the disease each year. As soon as the disease appears resistant varieties should be planted.

The following table, summarizing the data relative to resistant varieties now on the market will aid in formulating a planting program for infested soils. The days from setting of plants to maturity are approximate and dependent upon weather conditions. The yellows-resistance given is that which the best selected strains of the variety in question should possess.

Variety or strain	Days to maturity	Yellows-resistance, per cent
	Early	
Jersey Queen	60 to 70	98 to 100
Detroit Resistant	60 to 70	80
Resistant Golden Acre	60 to 70	80
	Mid-Season (Domestic or Kraut)	
Racine Market	65 to 75	95 to 100
All Head Select (flat)	70 to 80	95 to 100
Early Copenhagen Resistant	70 to 80	95 to 100
Marion Market	75 to 85	95 to 100
Glory Yellows Resistant	75 to 85	95 to 100
Globe	80 to 90	95 to 100
Wis. All Season (flat)	100 to 110	90 to 100
	Late (Danish)	
Wis. Ballhead	85 to 95	97 to 100
Bugner	95 to 105	Intermediate
Wis. Hollander	100 to 110	Highly resistant
Wis. Hollander No. 8	100 to 110	Highly resistant
Red Hollander Resistant	110 to 120	Highly resistant

Any one of the following mid-season or kraut varieties are recommended for yellows-infested fields: Racine Market, Early Copenhagen Resistant, Marion Market, Glory Yellows Resistant, Globe, All Head Select, and Wisconsin All Season. The last two are flat-headed, the others spherical in shape.

Of the early varieties, Jersey Queen is excellent from a resistance standpoint but does not yield heavily, while Detroit Resistant and Resistant Golden Acre need further selection for yellows resistance. Resistant Golden Acre and Detroit Resistant yielded very well on infested soil even tho some of the plants were susceptible.

None of the late varieties tested entirely meets the needs of New York growers. They are either of undesirable quality, yield less, or are not sufficiently resistant. For a special market where storage is not a factor, Wisconsin Ballhead with its smaller compact head and almost complete resistance should give good results. If a late better storage cabbage is desired and the market is not too exacting the Wisconsin Hollander types will serve and produce commercial yields in spite of their lower resistance. The Resistant Red Hollander is recommended also for special markets.